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PROGRESS REPORT

ON THE

SNOWSHOE HARE REPELLENT AND POISON STUDIES

CONDUCTED ON THE NICOLET NATIONAL FOREST

IN 1941 AND 1942

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REPORT ON THE SNOWSHOE HARE REPELLENT AND POISON STUDIES CONDUCTED ON THE NICOLET NATIONAL FOREST IN 1941 AND 1942

By Deane W. Mather, Robert H. Gensch and H. Allen Barton *

INTRODUCTION

Agencies planting trees in areas occupied by the snowshoe hare have long been concerned with losses due to the work of this animal. Concurrent with the expanded public reforestation program in 1933, control of the snowshoe hare by the use of a poison bait was attempted, but this type of control did not meet with public approval, so it was abandoned, before its effectiveness was fully determined. In 1934-35, H. J. Spencer of the Fish and Wildlife Service developed a poison method (poisoned aspen boughs) on the Chequamegon National Forest which was decidedly specific for snowshoe hares. This method of control was not applied extensively in Wisconsin due to adverse public opinion and the lowering of the hare population, brought about by the cyclic die-off in 1935. Various methods of mechanical control, such as shooting, snaring, driving, and live trapping were also tried with the final adoption of shooting and snaring by CCC personnel. These methods proved satisfactory under certain local conditions, but when applied to the majority of the existing problem areas, they either failed to produce the desired results or were too costly. In the last analysis, it was the die-off phase of the hare cycle, not mechanical control, that minimized hare damage to plantations.

In 1939, 1940, and 1941, studies were made on the Nicolet National Forest to determine the value of tree spray repellents developed by the Fish and Wildlife Service in protecting young trees from hare injury. The hare population in the Nicolet National Forest had just passed the low phase of the cycle in 1939, consequently the damage in all these studies except one experimental area near Alvin, Wisconsin was negligible regardless of whether the trees were treated or not. It was finally decided that controlled conditions were needed in order to reach reliable conclusions within a reasonable period of time. Studies within hare-proof inclosures of 4 acres in size were finally undertaken. Four of these inclosures were constructed near the Blackwell CCC Camp on the Laona Ranger District of the Nicolet National

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* The October 1942 examinations were made and analyzed by Shaler E. Aldous and Jack F. Welch as Mather and Gensch were ~~both removed~~ TRANSFERRED from the Nicolet National Forest before that time. The rough draft of this report was turned over to Aldous, who is responsible for placing it in its final form. Both Welch and Aldous contributed materially to the study. They assisted in planning and executing the studies and sprayed all of the seedlings used in the tests. All of the repellent and poison sprays were developed and furnished by the Wildlife Research Laboratory at Denver, Colorado.

Forest. See Figure 1 for map of the exact location. This area was chosen because it was a natural hare habitat, and adequate labor and materials were available at the camp for constructing the fences and planting the trees. Its suitability for hare habitation was evidenced by the fact that 23 live hares were trapped on and within 200 feet of the area.

The following personnel, other than the authors, have been associated with these studies, either by assisting in the field work or in planning, advisory, or cooperative capacities: For the U. S. Forest Service--R. R. Hill, H. B. Wales, H. E. Ochsner, G. W. Jones, H. F. Olson, G. W. Pike, D. N. Kee, W. W. Intermill, J. W. Jay, E. E. Aamodt, and G. A. Limstrom; for the CCC--W. J. Welch, W. H. Livens, and R. W. Mentz; for the Fish and Wildlife Service--J. F. Welch and S. E. Aldous; for the Wisconsin Conservation Department--E. F. Swift, F. G. Wilson, W. E. Scott, and D. J. Mackie.

PURPOSE OF THE STUDIES

The studies were designed to yield information on the value of repellent sprays applied to transplant trees and the effectiveness of certain poison paints applied to aspen boughs and exposed to hares. Two qualities of the repellent sprays were tested -- their effectiveness in deterring hares from the treated trees and their effect on the survival and growth of the trees. The repellent and poison mixtures were developed in the Denver Wildlife Research Laboratory of the Fish and Wildlife Service.

REPELLENT STUDIES

Repellent studies were conducted in 3 of the 4 four-acre inclosures. The fourth pen was reserved for emergency work or was to be left hare free if not needed.

The repellent studies in these pens were started in the fall of 1941 and pen 2 was used for these experiments. In the spring of 1942 two additional sets of experiments were started using pens 1 and 3. These studies will hereafter be referred to by the respective pen numbers. The pens are numbered consecutively from 1 to 4 in the order in which they are approached from the service road.

Pen 2 Studies

This study involved the use of 2-1 red pine heavily treated with T.P.109* applied to the trees in the nursery bed just prior to being lifted and planted in the fall of 1941. The purpose of this experiment was to test the effectiveness of a fall treatment in protecting fall planted stock from the depredations of hares both before snow

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*Formula in Table 17.

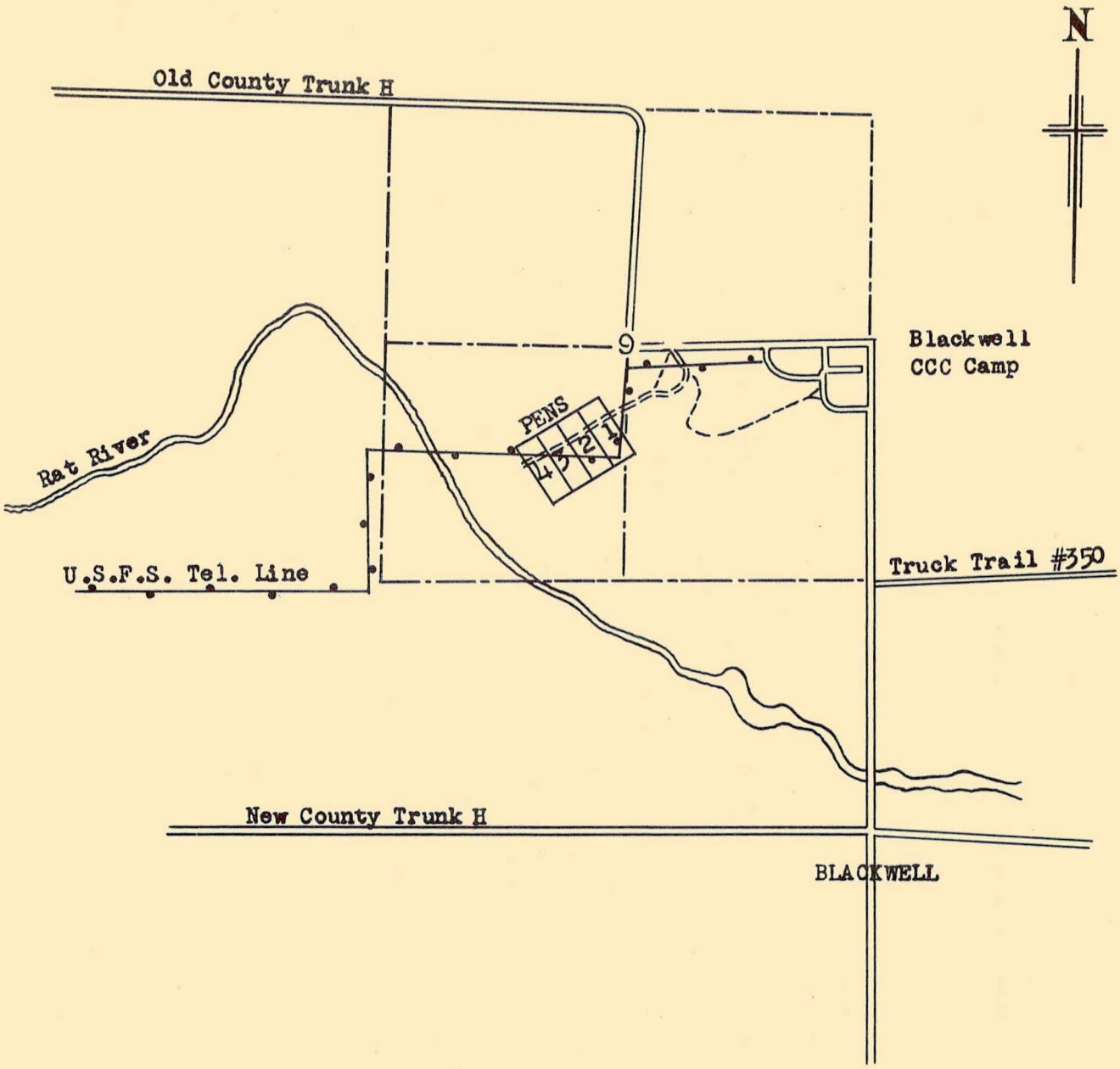


Fig. 1. Map showing the location of the snowshoe hare repellent studies. Section 9, T. 35 N., R. 15 E. Scale-3 inches to the mile.

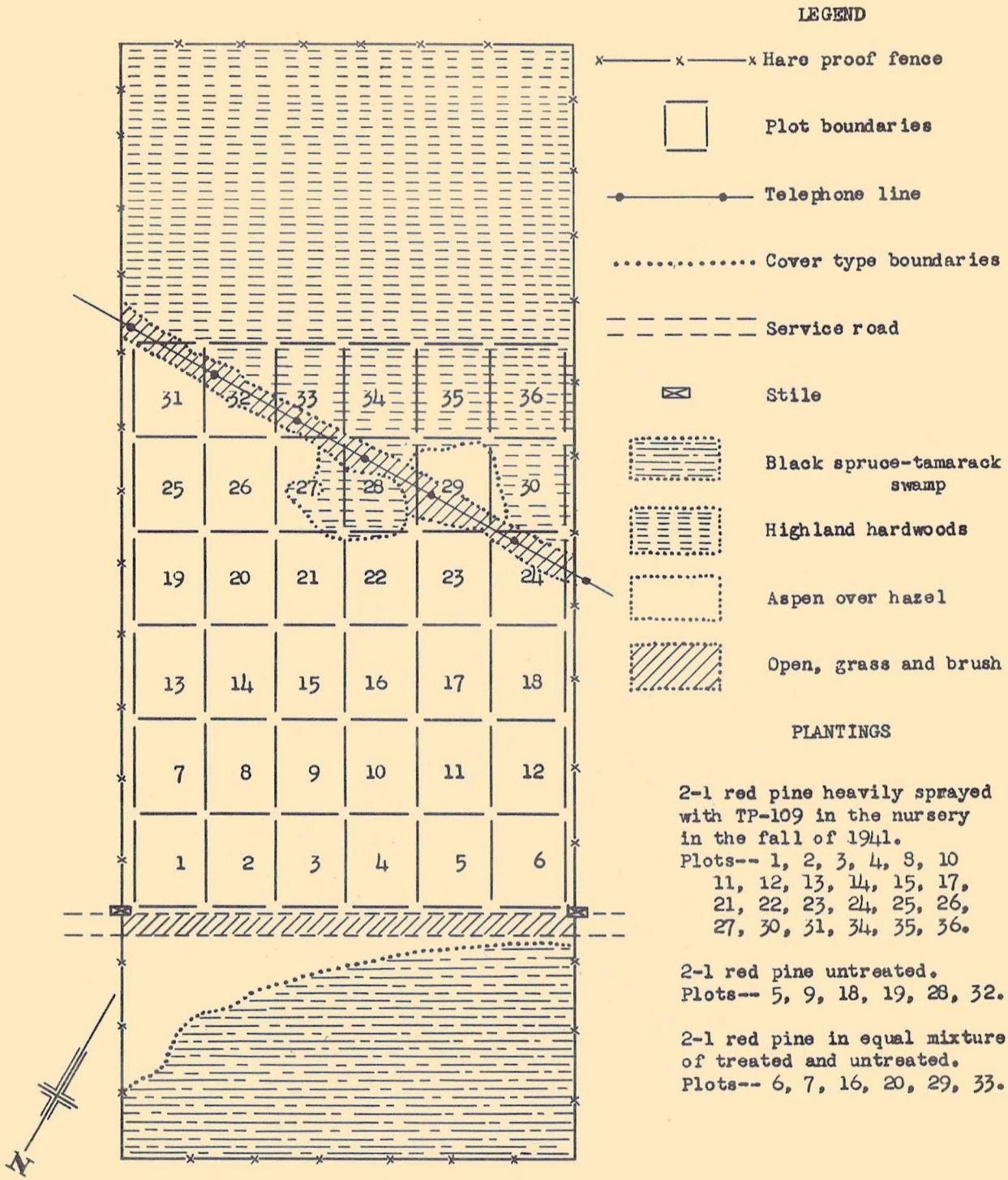

LEGEND
Hare proof fence
Plot boundaries
Telephone line
Cover type boundaries
Service road
Stile
Black spruce-tamarack swamp
Highland hardwoods
Aspen over hazel
Open, grass and brush
PLANTINGS
2-1 red pine heavily sprayed with TP-109 in the nursery in the fall of 1941.
Plots-- 1, 2, 3, 4, 8, 10 11, 12, 13, 14, 15, 17, 21, 22, 23, 24, 25, 26, 27, 30, 31, 34, 35, 36.
2-1 red pine untreated.
Plots-- 5, 9, 18, 19, 28, 32.
2-1 red pine in equal mixture of treated and untreated.
Plots-- 6, 7, 16, 20, 29, 33.
31 32 33 34 35 36
25 26 27 28 29 30
19 20 21 22 23 24
13 14 15 16 17 18
7 8 9 10 11 12
1 2 3 4 5 6
N

FIG. 2. MAP OF PEN 2.

covered them and after they were again exposed in the spring. The effect of the spray on the trees was also checked.

Three types of plot arrangements were made -- solid blocks of treated trees, solid blocks of check or untreated trees, and mixed blocks of treated and untreated trees. The original plan specified retreatment in the field of certain blocks of the treated trees at the beginning, middle, and end of the following growing season. This plan, however, was abandoned due to the war and the subsequent loss of personnel. The plantation was divided into 36 plots. The design and the designated type of stock planted on each is shown in Figure 2.

Plot Establishment

The arrangement of the trees in the plots is shown in Figure 3.

Figure 3. The Tree Numbering System Used in Pens 2 and 3.

7	8	21	22	36	37	50
6	9	20	23	35	38	49
5	10	19	24 25	34	39	48
4	11	18	26	33	40	47
3	12	17	27	32	41	46
2	13	16	28	31	42	45
1	14	15	29	30	43	44

Untreated trees were planted at the underlined tree locations in pen 2 and fall treated trees were planted at these locations in pen 3.

The trees were numbered by attaching a numbered metal tag to a lath located at each tree. The numbering system used was to prefix each tree number with the plot number, so that plot one trees would be 101, 102, 103. Plot 16 trees would be 1601, 1602, etc. In the mixed plots the underlined numbers indicated untreated trees. In the field the treatment was identified by the color of the stake, the untreated tree location being painted yellow and the treated left uncolored.

The three treatments were randomized in order to make the results statistically sound.

Planting

Planting was done by enrollees from the Blackwell Veterans CCC Camp with close supervision on the part of the authors which insured

an almost perfect planting job. The original plan also specified a plantation release in about June of 1942 because the area had too much cover to be an ideal red pine site. This, like the field treatments, was abandoned and the effect of the heavy shade in parts of the area probably contributed to the death of many trees by October 1942.

Hare Releases in Pen 2.

Three hare introductions were made into Pen 2 (Table 1). The first, consisting of 10 animals, was made on October 16 and 17, just five days prior to planting the trees in the pen. This gave the animals a short time to establish themselves in the new habitat.

Censuses made late in October, November, and December, and early in January (Table 2) show that there was at least an average of 8 hares in the pen or a population of two hares per acre for the first 6 weeks or until after the trees were covered with snow.

TABLE 1.--Tag numbers and sex of the hares released in Pen 2

First hare release October 17, 1941		Second hare release February 26, 1942		Third hare release May 7, 1942	
Tag No.	Sex	Tag No.	Sex	Tag No.	Sex
252	Male	284	Female	1267	Female
255	Female	293	Male	1272	Male
259	Female	1277	Female	1288	Male
260	Male	1278	Female	1290	Female
264	Female	1292	Male	1328	Male
265	Female	1355	Male	1333	Female
268	Female	1381	Female	1335	Male
274	Male	1388	Male	1382	Male
No tag	?	1392	Female	1383	Male
No tag	?	1396	Male	1391	Female

The second hare release of 10 hares in Pen 2 was made on February 26, in order to have a population in the pens when the trees were again exposed by the receding snow. An equal sex ratio was used in this introduction to allow for normal breeding. The loss of hares from the first introduction was felt to be due to unauthorized hunting with dogs within the pen. On February 28, dogs and hunters were known to enter the enclosure and practically annihilated the new population. This necessitated a third introduction which was made on May 7. In the meantime warning signs were posted around the area.

Censuses made in May and June indicated a consistent population of at least 8 animals. Settling of the fence in a few places may have been the source of some loss of animals, but that was remedied as soon as detected. Population counts have not been made since June but live trapping is contemplated in January 1943.

TABLE 2.--Hare population determinations in Pen 2

Census date	Number of hares seen: In swamp	In plantation	In hardwoods	Totals seen	Population estimation
October					
17	10 hares released.				
28	3	3	2	8	8
29	3	3	2	8	8
November					
6	3	3	2	8	8
12	2	3	1	6	8
13	2	4	2	8	8
19	1	4	1	6	7
26	1	3	3	7	7
27	2	4	0	6	6
December					
3	2	2	1	5	5
10	3	2	0	5	5
17	-	-	-	-	-
18	3	1	0	2	2
24	0	0	5	5	5
January					
30	1	1	0	2	2
February					
26	Release of 10 hares later killed by dogs and hunters (Feb. 28, 1943)				
May					
7	Spring release of 10 hares.				
9	3	4	2	9	9
14	-	3	1	4	9
15	-	3	2	5	9
20	-	2	2	4	7+1*
21	2	2	3	7	7+1
27	-	2	-	2	7+1
June					
6	-	-	3	3	5+1
23	1	-	-	1	2+1
24	-	-	-	-	1+1

* +1 indicates young unmarked hares.

Condition of Trees

The 2-1 red pine used in pen No. 2 were quite uniform as is indicated by a tabulation of buds and laterals shown in Table 3. Height measurements taken at the time of planting show that the trees were quite uniform. It was found that 85 percent of the trees were between 4½ and 7 inches in height.

TABLE 3.--The number of buds, leaders and laterals on the trees in Pen 2 at the time of planting

Type of treatment	Total plots	Total trees	Buds: Leader No.	Leader Av.	Lateral No.	Lateral Av.	Leaders No.	Leaders Av.	Laterals No.	Laterals Av.
Treated blocks	24	1,200	2,901	2.4	988	0.8	1,285	1.1	907	0.8
Untreated blocks	6	300	763	2.5	237	0.8	317	1.1	238	0.8
Mixture treated and untreated	6	300	737	2.5	293	1.0	318	1.1	248	0.8
	36	1,800	4,401	2.4	1,518	0.8	1,920	1.1	1,393	0.8

Field measurements of heights in the fall and again in the spring showed both effects of frost heaving and ground settling. Fifty-nine percent were raised by frost increasing the height of these trees by .77 of an inch per tree, 35 percent remained stationary and 6 percent showed signs of the ground settling causing a loss of .6 inch per tree. In gathering other factors that had an influence on the condition of the trees it was found that 3 percent of the treated trees and 3.6 percent of the untreated trees were poorly planted. Four and one-tenth percent treated and 2.9 percent untreated were damaged before planting; and 10.9 percent treated and 7.3 percent untreated were of poor stock.

The trees were examined for hare damage each week for six weeks after planting. In the spring four examinations were made after May 7 when the third hare population was introduced. These were made at the end of the first, second, third, and fifth weeks. A final examination was made in October, 22 weeks after the last hare introduction. The results of these inspections are shown in Table 4 and reflect the gradual increase in the percent of trees damaged.

The 1941 fall study represents an exceptionally severe test because it is unusual to find a six-weeks period after October 22 when small trees would not be covered by snow. The effectiveness of repellent 109 in preventing hare damage in the fall and early spring is well illustrated by the data in Table 4. Fall damage amounted to only about 2 percent which increased early in the spring to 3 percent. Contrasted to this is the high percent of vulnerability of the untreated

TABLE 4.--Accumulative hare damage to the trees in Pen 2

		Treatment			
		T.P.-109* in solid blocks Fall treatment	T.P.-109* in mixture Fall treatment	Untreated in solid blocks	Untreated in mixture
Number of trees planted		1200	150	300	150
			Percent damaged		
Accumulative hare damage by weeks after hare introduction. October-Dec. 1941 Dormant period.	1 wk.	0.4	2.0	16.0	21.0
	2 wk.	0.7	2.0	50.0	55.0
	3 wk.	0.8	2.0	85.0	84.0
	4 wk.	0.9	2.0	94.0	93.0
	5 wk.	1.0	2.0	96.0	95.0
	6 wk.	1.8	2.0	98.0	98.5
Accumulative hare damage after spring hare introduction. May-October 1942 Growing season.	1 wk.	2.6	6.7	99.3	100.0
	2 wk.	3.0	6.7	99.3	100.0
	3 wk.	16.9	22.7	99.3	100.0
	5 wk.	30.6	38.0	99.3	100.0
	22 wk.	76.0	75.4	99.6	100.0
Percent of trees dead October 1942		22.2	24.3	38.0	40.6

*Hare damage to T.P. 109 treated trees from May to October was confined mostly to new growth.

trees both in mixtures and in solid blocks where almost 100 percent were damaged by the time the trees were covered with snow in December.

Analysis of the record sheets reveals quite a few untreated trees that were redamaged as many as five times whereas the treated ones were rarely damaged. At the end of the first 6 weeks about 58 percent of the untreated trees had been redamaged while only a few of the treated trees had suffered additional injuries.

As soon as the new growth emerged in the late spring the hares attacked the green parts not protected by the spray. In three weeks after the new growth appeared on the treated trees the percent of damage jumped from 3 to over 17 percent. By the fall of 1942 this had further increased to 75 percent. The differences in the amount of injury to the trees planted in solid blocks or in mixtures was so small as to be insignificant.

Degree of Damage

The severity of the damage to individual trees varied from the removal of a single bud to cutting the tree at the ground line. The more severe damage occurred to untreated trees. Among treated trees, for the most part, the damage was restricted to the new growth.

The total damage to individual blocks of treated trees varied from 6 to 64 percent in solid blocks and from 16 to 56 percent in mixtures. The reason for this variability is not understood unless the higher figures are in plots where there is overlapping in individual hare territories. The greater damage percentages might indicate what can be expected under a heavier hare population pressure.

The percent of dead trees at the conclusion of the one year study, as indicated in Table 4, shows that hares were responsible for considerable tree mortality. The combinations of poor stock, poor planting, and hare injury together were less fatal to the treated trees than these same factors were to the untreated trees. The exceptionally wet period during late spring may have been responsible for the low mortality among the trees up to that time.

Results of Fall 1942 Examination

A somewhat different examination was made in October 1942 by Welch and Aldous and the results of their data are shown in Table 5.

In Table 5 those trees classified as thrifty will likely survive; those unthrifty will probably die. Those with good new growth had little or no recent damage to the new growth. Those with a trace of new growth were in most cases recently fed on by hares leaving only a trace of the new needles. Those with no new growth were either unthrifty trees which had not produced new growth or those on which all new parts had been removed by the hares. Many of the latter group of trees will die.

TABLE 5.--Results of the October 1942 examination of trees in Pen 2

Analysis	Untreated in solid block	Untreated in mixture	Fall treated T.P.-109 in solid block	Fall treated T.P.-109 in mixture
Number of trees planted	300	150	1,200	150
Percent of trees dead	38.0	40.6	22.2	24.3
Percent of live trees thrifty	21.5	13.5	83.9	79.7
Percent of live trees unthrifty	78.5	86.5	16.1	20.3
Percent of live trees with good new growth	1.6	3.3	11.8	10.6
Percent of live trees with a trace of new growth	4.3	3.3	49.3	41.6
Percent of live trees with no new growth	94.1	93.4	38.9	47.8
Percent of trees damaged by hares	99.6	100.0	76.0	75.4
Percent of hare injured trees that were dead	37.8	40.6	9.6	12.4
Percent of dead trees that were hare injured	99.2	100.0	32.7	37.9
Percent of trees in which hare injury may have been the cause or contributed to the cause of death	37.6	40.6	7.2	9.2

Conclusions from Pen 2 Studies

1. Fall planted 2-1 red pine which were treated with T. P. 109 in the nursery shortly before lifting were protected from hare injury until the trees were covered with snow in the fall and until new growth started in the spring.

2. Concurrent with spring growth, damage to the new growth by hares occurs beyond the reaches of the deterrent spray. The sprayed portion is rarely cut and when this occurs it is usually left lying on the ground and not eaten.

3. The survival of treated trees is believed to be exceptionally good due to excessive spring precipitation in 1942. There is evidence which indicates that T. P. 109 may be injurious to trees chiefly when aided by other factors such as poor site, poor planting, plant competition, drouth, and hare damage.

Pen 3 Studies

This study was started in the spring of 1942 and was designed to determine the protection afforded spring planted 2-1 red pine by repellent T. P. 109. Part of the trees used were treated in the nursery

the previous fall and the others were treated in the nursery in the spring just prior to planting.

The plot design and tree numbering were identical with that used in Pen 2. A map of pen 3 is shown in Figure 4. The treatments were randomized for statistical soundness. A preponderance of spring treated stock was planted because the original plan called for field treating of this stock. The field treatments and plantation release that were originally contemplated were not made, however, due to the war and lack of personnel. The mixed plots in this study consisted of a mixture of spring treated trees T. P. 109 (S-109) and fall treated trees T. P. 109 (F-109). The underlined numbers in Figure 3, page 5 indicated the fall treated trees.

Hare Introduction

One hare introduction was made in Pen 3 on May 8, 1942, as indicated in Table 6, at which time 9 animals were released.

The population estimates in Table 7 were made by projecting back into earlier dates, hares which were identified (by colored ear tags) on the later dates but not on earlier ones, showing that they were present but not observed.

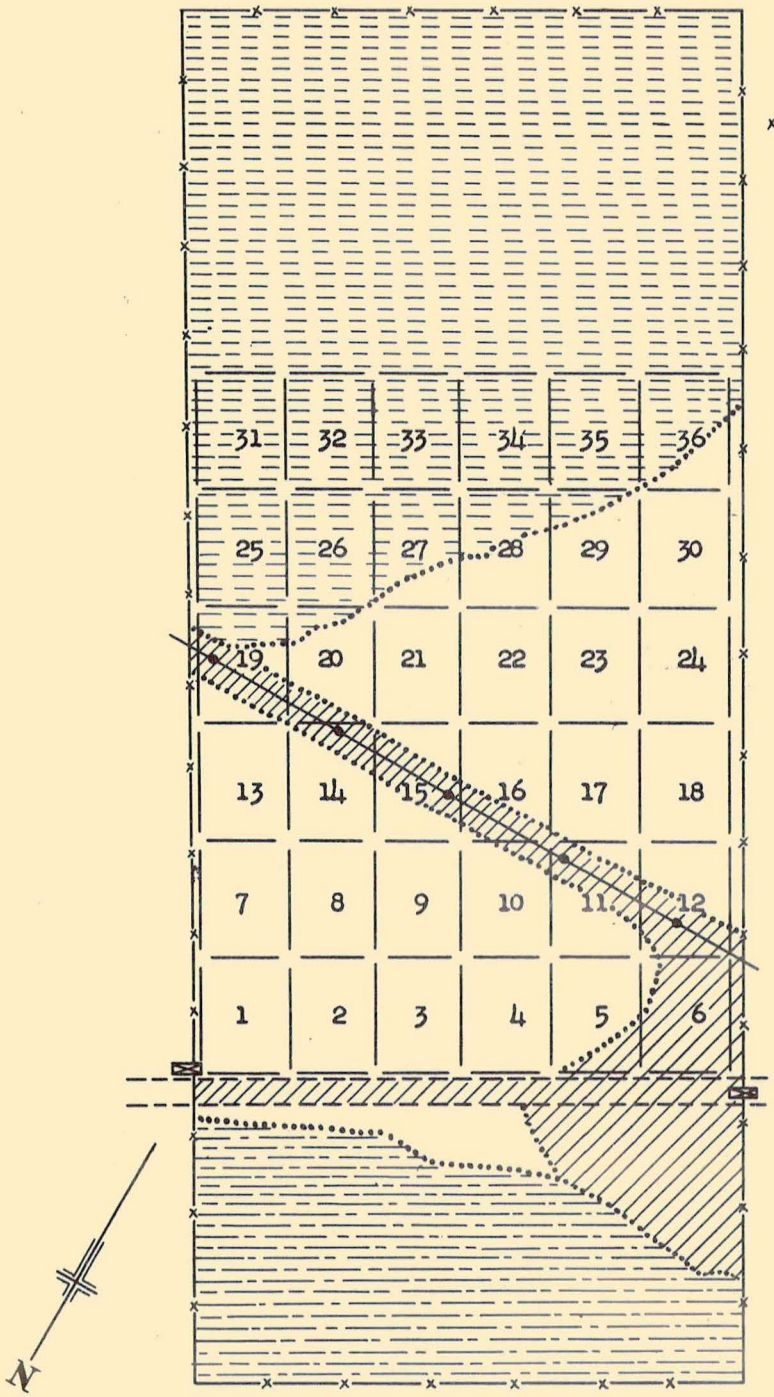
TABLE 6.--Hares released in Pen 3, May 8, 1942

Tag Number	Sex
1257	Female
1262	Female
1271	Male
1274	Female
1279	Male
1297	Male
1334	Male
1386	Male
1389	Male

A series of censuses made between May 9 and June 30 indicated that at least 8 animals were in the pen during that period (Table 7). What has happened to them since that time will not be known until trapping operations are completed this winter (1943).

Planting

To simplify the task of planting and checking, the lath at each tree location was painted to designate the type of treatment the tree received. Yellow lath indicated untreated trees, red lath fall treated and unpainted lath indicated spring treated trees.



LEGEND

Hare proof fence

Plot boundaries

Telephone line

Cover type boundaries

Service road

Stile

Black spruce swamp

Highland hardwoods

Aspen over hazel

Open, grass and brush

PLANTINGS

2-1 red pine used throughout.

S-109-heavy in plots:- 1, 2, ½ of 3, 4, 8, 10, 11, 14, 15, 17, 21, 23, 24, 25, 27, 30, 31, 34, 36.

F-109-heavy in plots:- ½ of 3, 12, 13, 22, 26, 35.

Mixture of S109-heavy and F-109-heavy in plots:- 6, 7, 16, 20, 29, 33.

Untreated trees in plots:- 5, 9, 18, 19, 28, 32.

FIG. 4. MAP OF PEN 3

TABLE 7.--Hare population determinations in Pen 3. The Plus 1 figures indicate young unmarked animals

Census date	Number In swamp	Number In plantation	Number In hardwoods	Total seen	Population estimate
May 9	0	0	0	0	7
May 13	0	0	0	0	7
May 14	0	0	0	0	7
May 15	0	0	4	4	7 + 1
May 16	0	2	1	3	7 + 1
May 20	1	0	2	3	7 + 1
May 27	0	1	0	1	7 + 1
June 3	0	1	2	3	7 + 1
June 17	0	1 + 1	0	1 + 1	7 + 1
June 24	0	2 + 1	0	2 + 1	7 + 1

A few errors were made in planting the trees in Pen 3 due to the lack of close supervision. This resulted from an unusually early spring and an overload of work on the part of the authors. These errors were located and have been corrected in all examinations since establishment of the area. Planting was done without ground preparation due to a labor shortage. This may have some effect on future growth and survival but such was not particularly noticeable during the first year. No attempt was made to analyze the tree stock used in Pen 3 but inasmuch as it was from the same source as that used in Pen 2 it can be assumed that the uniformity was about the same. (See Table 3.) When the Pen 3 trees were being examined, notations were made of poor stock, poor planting pre-planting injuries, etc. A summation of this data is shown in Table 8.

TABLE 8.--Factors Affecting Pen 3 trees

Type of treatment	Total number of trees planted	Poor planting No.	Poor planting Percent	Damaged before planting No.	Damaged before planting Percent	Poor stock No.	Poor stock Percent
F-109 in blocks	278	0	-	37	13.7	11	3.9
F-109 in mixture	146	1	0.7	20	13.0	5	3.4
Total F-109	424	1	0.2	57	13.4	16	3.8
S-109 in blocks	905	8	0.9	48	5.3	24	2.7
S-109 in mixture	146	0	-	13	8.9	5	3.4
Total S-109	1,051	8	0.8	61	5.8	29	2.8
Untreated	298	0	0	19	6.4	11	3.7

These are conservative figures, but give some indication of the extent to which tree damage prevailed at the time of planting. This may have been due to hare, cottontail rabbit, squirrel, bird, frost, or mechanical damage in the nursery. It was necessary to keep individual tree records on this condition so it would not be considered as hare damage on any subsequent examination.

Hare Damage to Pen 3 Trees

Pen 3 trees were examined for hare injury at the end of the first, second, third, fifth and twenty-second weeks after planting. The results of these inspections are shown in Table 9.

TABLE 9.--Accumulative hare damage to trees in Pen 3

Treatment	Number of trees planted	Accumulative damage in percent: Weeks after spring hare introduction					Percent of trees dead
		1	2	3	5	22	
F-109 in solid blocks	278	5.0	7.9	11.2	21.9	47.1	41.4
F-109 in mixture	146	2.7	6.8	14.4	21.9	46.5	32.2
S-109 in solid blocks	903	1.5	3.3	6.6	18.3	49.1	19.3
S-109 in mixture	146	2.7	6.8	11.6	17.8	52.7	18.5
Untreated in solid blocks	292	4.7	10.7	18.1	39.3	65.4	9.9

The differences in the percent of hare injury to spring and fall treated trees was so small on each successive examination that little differentiation can be attributed to these treatments. The percent of injury to the untreated trees was consistently higher, which shows that the repellent was somewhat effective in protecting the treated trees from injury. Table 10 shows the condition of the trees in Pen 3 as of October 1942 and these figures bring out several interesting facts. Where damaged treated and untreated trees have an equal chance of survival, except for the hare injury, it appears that the higher mortality among treated trees results from the spray. The fall applied T.P. 109 was responsible for killing a larger percent of the hare damaged trees than was the spring applied 109. The mortality among the F-109 trees planted in the spring is much higher than the same trees planted in the fall. The reason for this is rather obscure. All the evidence indicates that the survival of undamaged treated trees is equally as good and sometimes better than untreated. However, with the removal of the new growth by the hare the treated tree tends to succumb more easily than the untreated tree. It appears also that fall treated trees are more apt to succumb than are ~~spring treated if~~ TREES TREATED JUST PRIOR TO SPRING PLANTING. held in the nursery and planted in the spring.

TABLE 10.--Results of the October 1942 check of trees in Pen 3

Analysis	Untreated in solid blocks	F-109 in solid blocks	F-109 in mixture	S-109 in solid blocks	S-109 in mixture
Number of trees planted	292	278	146	903	146
Percent of trees dead	9.9	41.4	32.2	19.3	18.5
Percent of live trees unthrifty	3.2	11.4	19.2	6.5	8.4
Percent of live trees thrifty	96.8	89.6	80.8	93.5	91.6
Percent of live trees with good new growth	52.1	55.9	54.5	65.6	55.4
Percent of live trees with a trace of new growth	23.2	28.8	21.2	19.0	32.0
Percent of live trees with no new growth	24.7	15.3	24.3	15.4	14.6
Percent of trees damaged by hares	65.4	47.1	46.5	49.1	52.7
Percent of hare injured trees that were dead	3.1	16.8	16.2	6.1	3.9
Percent of dead trees that were hare injured	20.6	19.0	23.4	15.5	11.1
Percent of trees in which hare injury may have been the cause or contributed to the cause of death	2.0	7.8	7.5	2.9	2.0

While Table 9 shows the average damage inflicted to trees with each treatment, considerable variation in individual plots was found. At the end of the 5 weeks period the minimum and maximum damage to plots was recorded and is shown in Table 11.

TABLE 11.--The minimum and maximum percentages of hare damage to individual plots in Pen 3 at the end of the fifth week

Treatment	Minimum percent of damage in any one plot	Maximum percent of damage in any one plot
S-109 in blocks	2.0	46.0
S-109 in mixture	4.0	24.0
F-109 in blocks	10.0	36.0
F-109 in mixture	4.0	40.0
Untreated	12.0	62.0

The reason for this extreme variation is not fully understood but it is believed that an uneven distribution of hares over the area brought about by the degree of cover available, is partially responsible. It was noticeable during the field examination that those plots largely in open territory had less hare injury.

Conclusions from Pen 3 Studies

1. Spring planted trees, whether treated with T.P. 109 in the fall or spring were about equally protected from hares up to 22 weeks after planting.

2. Untreated trees were much more vulnerable to hare injury than the treated trees.

3. The survival rate of spring treated trees was much better than fall treated trees when both were planted in the spring. This indicates that treated trees left in the nursery bed all winter may be injured, ~~possibly~~ by the repellent coating. ~~causing excessive light absorption.~~

4. The injury to all trees at the end of 22 weeks averages about 50 percent but most of the damage was of minor significance. Damage to treated trees consists almost entirely of injury to new growth.

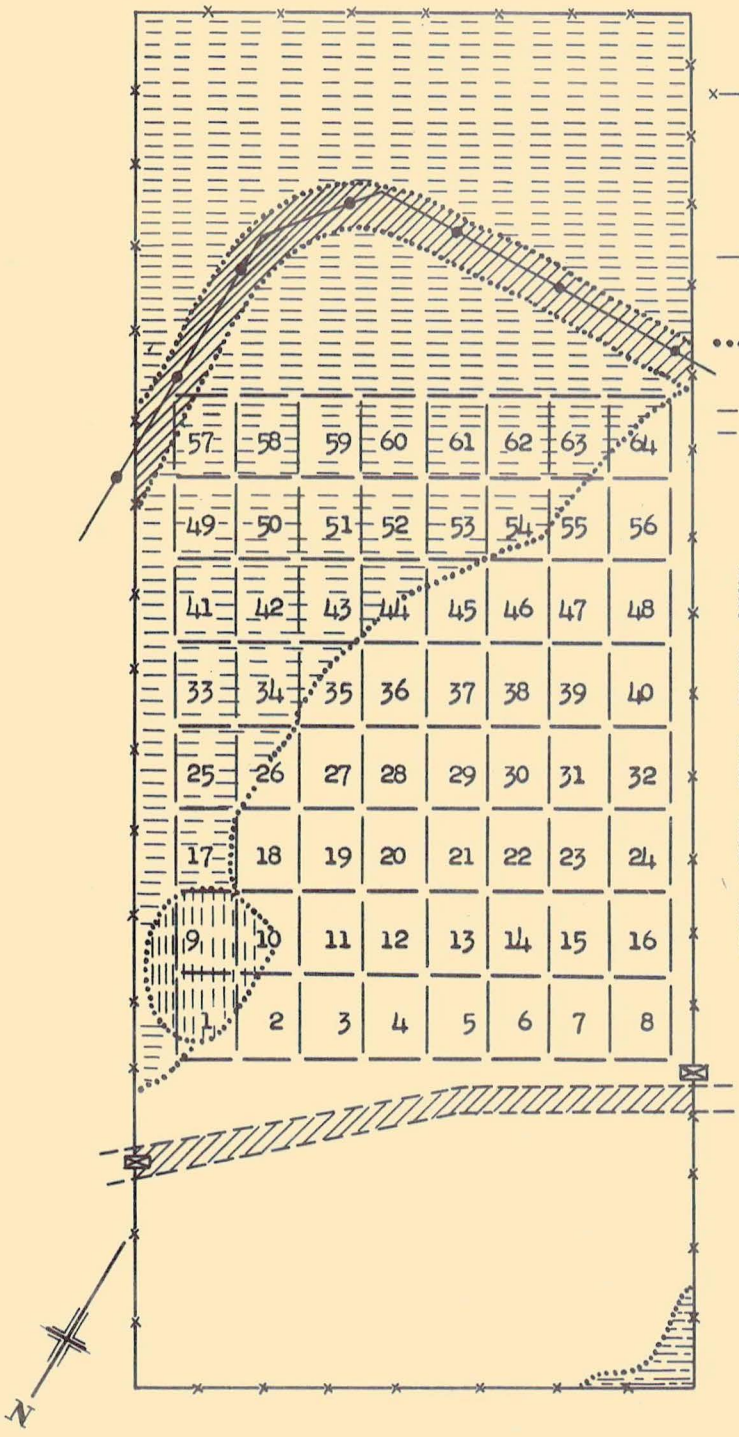
Pen 1 Studies

A field examination near Alvin, Wisconsin in April 1942 of a plantation established in 1940 indicated that there might be some injurious effects to trees from the T.P. 109 spray. The Pen 1 studies were designed, therefore, to test this effect by giving (2-1) red pine light, medium, and heavy treatments of the spray. Inasmuch as some of the ingredients used in the 109 formula are now unavailable due to the war it seemed also desirable to test similar sprays containing chemical substitutes for the scarcer ingredients. These sprays,* 5 in number, were also sprayed on (2-1) red pine and added to the Pen 1 studies. In order properly to randomize the 8 types of sprayed trees, a total of 64 plots were installed. Figure 5, which is a map of Pen 1, shows the design and distribution of treated stock in this study. Untreated stock was omitted to compel the hares to choose between treated samples. The numbering of the individual trees with marked lath was the same as used in Pens 2 and 3 but in Pen 1 only 25 trees per plot were planted. The arrangement of these 25 trees is shown in Figure 6.

FIGURE 6.--Arrangement of the trees in each plot of Pen 1

5	6	15	16	25
4	7	14	17	24
3	8	13	18	23
2	9	12	19	22
1	10	11	20	21

* Formulae in Table 17.



LEGEND

Hare proof fence

Plot boundaries

Telephone line

Cover type boundaries

Service road

Stile

Black spruce swamp

Highland hardwoods

Aspen over hazel

Open, grass and brush

Hemlock

PLANTINGS

2-1 red pine used throughout.

S-109-light in plots:- 7, 12, 24, 25, 37, 42, 54, 59.
S-109-medium in plots:- 1, 13, 18, 30, 35, 47, 52, 64.
S-109-heavy in plots:- 5, 10, 22, 27, 39, 44, 56, 57.
R-65-medium in plots:- 2, 14, 19, 31, 36, 48, 49, 61.
R-66-medium in plots:- 4, 16, 17, 29, 34, 46, 51, 63.
R-67-medium:- 6, 11, 23, 28, 40, 41, 53, 58.
R-68-medium:- 8, 9, 21, 26, 38, 43, 55, 60.
R-22-medium:- 3, 15, 20, 32, 33, 45, 50, 62.

FIG. 5. MAP OF PEN 1.

Factors Affecting Pen 1 Trees

Factors affecting the trees were recorded during the regular examinations. These are listed in Table 12. The size and uniformity of the stocks were probably about equivalent to those in Table 3 for Pen 2 trees, since the stock was all from a common source.

TABLE 12.--Factors that may have influenced Pen 3 trees

Type of treatment	Total number of trees planted	Poor planting: No.	Poor planting: Percent	Damaged before planting: No.	Damaged before planting: Percent	Poor stock: No.	Poor stock: Percent
S-109 Light	200	0	-	17	8.5	8	4.0
S-109 Medium	200	0	-	9	4.5	6	3.0
S-109 Heavy	200	1	0.5	21	10.5	9	4.5
R-22	200	2	1.0	17	8.5	10	5.0
R-65	200	1	0.5	14	7.0	7	3.5
R-66	200	5	2.5	16	8.0	4	2.0
R-67	200	4	2.0	13	6.5	10	5.0
R-68	200	1	0.5	12	6.0	6	3.0

Hare Introductions in Pen 1

On May 16, 1942, seven hares were released in Pen 1. In addition to these there were at least 3 other hares left in the pen from winter poison studies. Table 13 lists the ear tag numbers of the hares used in this pen.

TABLE 13.--Snowshoe hares introduced into Pen 1 on May 16, 1942

Tag No.	Sex	Tag No.	Sex
218 *	Male	1337	Male
1254	Male	1353*	Male
1255	Male	1379 **	Male
1268	Male	1390 **	Male
1332	Male	1394	Male
1336	Male	1395 *	Male

* One or more of these hares were believed to be in Pen 1 when the others were introduced.

** These hares positively known to be in Pen 1 on May 16.

Censuses conducted through May and June (Table 14) show that at least 8 and possibly 9 hares were in the area during that period. This made a population of about 2 to the acre.

TABLE 14.--Population estimates from censuses conducted in Pen 1

Dates of census	Number of animals seen: North of plantation	Number of animals seen: Plantation	Number of animals seen: South of plantation	Total number of hares seen	Estimated population
May 16	-	-	-	-	10 by introduction
May 21	2	3	0	5	8
May 23	0	0	0	0	8
May 28	-	2	1	3	7
June 4	0	0	0	0	7
June 22	2	-	0	2	7
June 23	2	0	0	2	5
June 24	1	2	2	5	5

Hare Injury to Pen 1 Trees

Checks made at the end of the first, second, third, fifth, and twenty-second weeks after planting showed the repellent qualities of all the sprays to be about equal. Table 15 shows the accumulative percentages of injury to Pen 1 trees.

TABLE 15.--The accumulative hare damage to the trees in Pen 1 (Spring planted)

Treatment	Number of trees planted	Damage in percent: 1st wk.	2nd wk.	3rd wk.	5th wk.	22nd wk.	Percent of trees dead
S-109 light	200	1.5	21.0	55.0	80.5	98.0	10.5
S-109 medium	200	5.5	19.0	57.0	78.5	92.5	13.5
S-109 heavy	200	1.0	15.5	54.0	69.0	83.5	17.5
R-65	200	3.0	21.0	66.5	81.0	95.0	12.5
R-66	200	2.5	21.5	64.5	80.5	94.5	14.5
R-67	200	3.5	12.5	48.0	63.5	90.5	15.0
R-68	200	4.5	21.5	66.5	82.0	94.5	13.5
R-22	200	7.5	18.0	62.5	75.5	95.5	8.5

There was little difference between the repelling qualities of 109-heavy and R-67, both of which were slightly more repelling than the others tested.

There is a little more differentiation between samples in their effect on tree survival. T.P. 109-heavy, as was expected, caused the greatest mortality and R-22 the least. The others were quite uniform in their effect.

There was considerable variation in the percent of hare injury to individual plots. This was probably due to uneven distribution of hares over the area caused by habitat variation and also to the highly erratic feeding habits of individual hares. Table 16 shows the condition of the trees at the time of the October 1942 survival counts.

Conclusions from Pen 1 Studies

1. While all damage was minor in character, the damage being restricted mainly to new growth, none of the repellents gave adequate protection on spring planted trees during the season.

2. S-109 in heavy concentration and R-67 in medium concentration gave the greatest degree of protection. However, 109-heavy also contributed to the highest mortality to trees.

3. Individual plot damage was quite variable, which indicated three things, namely uneven distribution of hares due to habitat preference, erratic feeding habits of individual animals, and a possible influence in this direction by an all male population.

Pen 4 Studies

This pen was left hare free for future studies. In May 1942 plantable areas in this pen north of the service road were planted to 2-1 red pine and portions south of the road to 3-2 white spruce. These plantations will serve as a check against the trees subjected to hare injury and spray effects in the other three pens.

Repellents Used

The formulae for all the repellent mixtures referred to in these studies are described in Table 17.

Nursery Studies of Repellent Damage to Tree Tissue and Tree Growth

Three series of study plots were set up in May 1942, at the Hugo Sauer Nursery, to determine the influence of rodent repellent sprays on the growth of 2-1 red pine transplants.

Series A

This study was designed to determine the effect on the trees of repellent concentration and repellent type. A total of 11 treatments and 1 control (untreated) were selected with a representation of 100 trees for each. These were planted in randomized plots of 25 trees each, making a total of 48 plots with 4 replications of each treatment and check. All treatments were made prior to lifting and planting in the study plots. The treatments given are listed in Table 18.

TABLE 16.--Results of the October 1942 examination of trees in Pen 1

Analysis	R-22	R-65	R-66	R-67	R-68	109 Light	109 Medium	109 Heavy
Number of trees planted	200	200	200	200	200	200	200	200
Percent of trees dead	8.5	12.5	14.5	15.0	13.5	10.5	13.5	17.5
Percent of live trees thrifty	85.3	89.7	90.0	90.6	90.8	91.6	83.8	84.8
Percent of live trees unthrifty	14.7	10.3	10.0	9.4	9.2	8.4	16.2	15.2
Percent of live trees with good new growth	13.1	10.3	7.6	8.8	11.1	6.7	12.1	15.2
Percent of live trees with a trace of new growth	16.9	23.4	31.0	15.9	26.6	31.1	29.4	31.5
Percent of live trees with no new growth	70.0	66.3	61.5	75.3	61.3	73.2	58.5	53.3
Percent of trees damaged by hares	95.5	95.0	94.5	90.5	94.5	98.0	92.5	83.5
Percent of hare injured trees that were dead	7.3	7.9	10.6	9.4	8.5	9.2	8.6	8.4
Percent of dead trees that were hare injured	82.4	60.0	69.0	56.7	59.4	85.7	59.3	40.0
Percent of trees in which hare injury may have been the cause or contributed to the cause of death	7.0	7.5	10.0	8.5	8.0	8.9	8.0	7.0

Replications were designated by the letters A, B, C, and D following the plot numbers used to designate the treatments.

During the week of July 13 to 18 the trees were inspected and measured. The length of leader and lateral growth, stem diameter, length of needles, and any plant injury which might be caused by the spray were recorded. Average measurements on the trees in each plot and for each treatment were prepared but the differences were so slight and the variations in original size of stock so great that no conclusions could be drawn as to the influence of the treatments on the growth of the plants. However, the July measurements will provide a base from which to work when future measurements are taken. No apparent injury was found from any of the treatments, although about 20 percent of the trees in the 109 fall treated plots were dead. This was probably due to poor handling rather than treatment, because the losses did not occur in the Series B-1 part of this study where all of the stock had this same treatment.

Series B-1

This portion of the study was designed to determine the effect of retreatment of trees with repellent sprays based on the time of treatment, where respraying is desirable to protect the new growth. This had particular reference to midseason spraying in the field.

TABLE 17.--Formulae for repellents used in the preceding studies

Repellent	Cost per gal.	Formula		Rate of application
109 Light	$1.49	1. Rezyl 53	4 lb.	1 pt./M
		Ethylene dichloride	5 qts.	
		2. Asphalt emulsion	4 lb.	
		Ethylene dichloride	5 qts.	
		Dissolve and mix 1 and 2		
		Add: Powdered copper carbonate (50% Grade)	5 lb.	
		Dry lime sulphur	5 lb.	
		Ethylene dichloride to make 5 gallons of spray		
109 Medium	1.49	Same		1 qt./M
109 Heavy	1.49	Same		3 qts./M
R-22	1.40	Same as R-66 except Rosin used in place of Rezyl 869		1 qt./M
R-65	1.42	Same as R-66 except Rezyl No. 12 used in place of Rezyl 869		1 qt./M
R-66	1.42	1. Rezyl 869	3 lb.	
		Ethylene dichloride	5 qt.	
		2. Asphalt emulsion	4 lb.	
		Ethylene dichloride	5 qt.	
		Dissolve and mix 1 and 2.		
		Add: Powdered copper carbonate (50% Grade)	5 lb.	
		Dry lime sulphur	5 lb.	
		Ethylene dichloride to make 5 gallons of spray		
R-67	0.38	Rosin emulsion	1 qt.	1 qt./M
		Water	2 qts.	
		Dry lime sulphur	½ lb.	
		Powdered copper carbonate (50% Grade)	½ lb.	
		(This preparation clogged the spray gun frequently. The emulsion apparently broke down on standing.)		
R-68	0.50	Asphalt Emulsion	2 lb.	1 qt./M
		Water	4 qts.	
		Dry lime sulphur	1 lb.	
		Powdered copper carbonate (50% Grade)	1 lb.	

TABLE 18.--Treatments used on 2-1 red pine transplants in Series A

Formula	Concentration	Time of Treatment	Plot No.
109	Heavy	Fall 1941	1
109	Heavy	Spring 1942	2
109	Medium	Spring 1942	3
109	Light	Spring 1942	4
Untreated	-----	----------	5
R-22	Medium	Spring 1942	6
R-65	Medium	Spring 1942	7
R-66	Medium	Spring 1942	8
R-67	Medium	Spring 1942	9
R-68	Heavy	Spring 1942	10
R-68	Medium	Spring 1942	11
R-68	Light	Spring 1942	12

The original treatment was made in the fall of 1941 with the 109 repellent and these trees were transplanted into study plots on May 10, 1942. Forty plots of 25 trees each were planted in a randomized pattern which provided 4 replications for each treatment. A retreatment of the 9 sets of plots with 109 spray was made at weekly intervals throughout May and June, during the period of their rapid growth.

Series B-2

This study was designed to determine the effect of the original treatment with repellent 109 based on the time of treatment. Untreated trees were planted in 40 plots of 25 trees each to provide for randomization of the 9 different types of treatment and an untreated check. The four replications were shown by the letters A, B, C and D. Treatments under Series B-1 and B-2 were identical following the planting of the trees in the study plots. The time of treatment is shown in Table 19.

TABLE 19.--The spray treatments given 2-1 red pine in series B-1 and B-2 studies

Plot and treatment number	Date of treatment
1	Untreated spring 1942
2	May 20, 1942
3	June 1, 1942
4	June 8, 1942
5	June 15, 1942
6	June 25, 1942
7	June 30, 1942
8	July 6, 1942
9	Untreated in 1942
10	Untreated in 1942

Due to the late date on which treatments were started, the plots numbered 9 and 10 were not needed.

Observations and measurements were made on the B series plots at the same time and in the same manner as in the case of the A series. Growth differences were not significant but some injury did show up on the plants. The trees were still in the candle stage of leader development up until the first week in June. Trees sprayed June 8 were the first ones on which the needles showed a definite black coating on the tips, approximately one-quarter of an inch long. Each successive spraying after this covered a needle surface of greater length due to normal plant growth. No injury to the needles was noted on July 11, when the first examination and measurements of some of the plots were started. On July 13, however, some of the needles were turning brown just below the part covered by the spray material. The part of the needle under the spray was still green, but later turned brown due to the death of the needle from the brown spot to the tip. The basal part of the needle remained green and healthy. A check on August 3 showed that not all of the needles on these trees were killed at the tips. In general, the injury to the needles was in proportion to the length covered by the spray material. Serious loss of needle surface was evident in treatments numbered 6, 7 and 8, which were treated after June 15, and some loss occurred on the trees treated on June 15. It can be anticipated that growth on these plants will be retarded for the balance of this year and next year. All of the plants now appear to be in a healthy condition, and it is believed that the loss of needle surface will not permanently injure these trees if the treatment is not repeated. The browning of the needles was probably due to the extremely warm weather experienced on July 11 and 12. The black coating on the tender needles probably caused excessive heat absorption which injured the underlying tissues. On the earliest treatments where the needle tissue was hardened very few needles showed this injury. It is ~~quite probable~~ possible that a light colored or transparent material would avoid this type of injury.

Conclusions

1. It will be necessary to wait through another growing season before growth differences can be definitely determined in any of the three series of plots and treatments.

2. In the case of spray materials having heat absorbing qualities, there is danger of needle injury during hot weather particularly when the needles have not had time to harden before the spray is applied. (Are we sure of heat absorbing as the cause? Have the chemical effects of specific ingredients been ruled out?)

3. Spraying with 109 repellent should not be done during the latter half of June and probably not after one-half inch of needle extends beyond the base of the needle sheath.

4. No injury was noticed from applying the spray material to the extended candles of the red pine transplants.

5. All treatments in the B-1 and B-2 series were heavy treatments and it is possible that lighter treatments would lessen or eliminate the needle damage.

POISON STUDIES

Since the development by Jack Spencer of the poison aspen bough method for snowshoe hare control, several field tests in the Superior National Forest have been made with quite erratic results. With the hope of determining some of the causes of the variable results a set of experiments under controlled conditions were devised. These experiments were carried out in the winter of 1941-42 at Blackwell, both in cages and in Pen 1. The original plan called for tests to determine the palatability ratings of 3 basic poison formulas (all ingredients minus the poison) for hares and deer, the effectiveness of microsized arsenic and strychnine as hare poisons and the rate of deterioration of the poison formulas. An extremely mild winter made it impractical to obtain a deer palatability rating. The rate of deterioration of the poison formulas was not determined because of the shortage of experimental animals.

The poison formulas that were tested are shown in Table 20.

TABLE 20.--Poison formulas used in poison studies

Laboratory No.	Ingredients		Approximate cost
TP 103A	Strychnine alkaloid	3 ounces	$2.45 per qt.
	Gum arabic glue	4 ounces	
	Water	24 ounces	
	Glycerine	5 ounces	
	Sodium bicarbonate	3 ounces	
	Maple sugar	12 ounces	
TP 103A(1)	Microsized arsenic	3 ounces	$1.15 per qt.
	Gum arabic glue	4 ounces	
	Water	24 ounces	
	Glycerine	5 ounces	
	Sodium bicarbonate	3 ounces	
	Maple sugar	12 ounces	
TP 103B	Microsized arsenic	6 ounces	$1.35 per qt.
	Gum arabic glue	4 ounces	
	Water	24 ounces	
	Glycerine	8 ounces	
	Karo corn syrup	12 ounces	
TP 103B(1)	Strychnine alkaloid	6 ounces	$3.00 per qt.
	Gum arabic glue	4 ounces	
	Water	24 ounces	
	Glycerine	8 ounces	
	Karo corn syrup	12 ounces	
TP 146	Strychnine alkaloid	10 ounces	$2.40 per qt.
	Lanum (Lanolin anhydrous)	16 ounces	
	Chloroform	1 gallon	
TP 146A	Microsized arsenic	10 ounces	$1.35 per qt.
	Lanum (Lanolin anhydrous)	16 ounces	
	Chloroform	1 gallon	

Preference Tests of Basic Formula, No Poisons, Cage Studies

Three separate tests were made of the preference selection of the three basic formulas by hares. For each test ten similar green aspen sticks were used. Each was ½ to 3/4 inch in diameter, forty inches long, and marked into four ten-inch sections. These sections each had a different treatment; formulas TP-103A, TP-103B, TP-146, and untreated were used. The location of the different treatments was randomized so as to eliminate the possibility of preference being influenced by its location on the stick. At the beginning of each test one stick was placed in the cage of each of ten hares. Each of these animals had access to other food consisting of aspen, jack pine, cracked corn, and ground wheat. Examination at various intervals showed the percent of bark eaten for each treatment. Table 21 summarizes the results from a series of thirty aspen sticks fed.

TABLE 21.--Summary of the preference tests of basic formulae based on the time interval

Time interval (Hours)	Percent of bark consumed			
	Untreated	Maple sugar	Corn syrup	Lanum oil
1 1/	11	8	tr	tr
3 1/	19	24	10	2
10 3/	5	5	3	3
13 1/	50	66	47	56
14 2/	38	47	47	17
18 3/	6	10	6	3
36 3/	10	22	12	3
92 2/	91	82	93	74
114 3/	51	56	53	36
Average percent consumed	65	68	65	55

1/ 2/ 3/ Alike symbols refer to results from the same group of 10 animals. Computed from average of total eaten by each group -- (13 hr., 92 and 114 hr.)

The data in Table 21 show a slight hare preference for the maple sugar treated aspen. During the first 36 hours this basic formula was eaten more readily than the others, but after that time the accumulated amount eaten on all samples was more or less equalized. The test did show, however, the extreme variability in the feeding habits of individual hares. Some take the food readily, while others are reluctant to take it even after many days. Extreme variation in the amount of bark eaten by individual hares was recorded. This partially explains the erratic results of poison work done in the Superior National Forest during the past few winters. It is also reflected in the field pen poison studies to be discussed later in this report. Because maple sugar might be attractive to deer, and since the basic formulae had about equal merit, it was decided that the pen tests with poison should be made using the basic formula containing lanum oil as well as the one using maple sugar.

Poison Studies in the Four-acre Field Pen

Four tests were made in the field pen using: (1) TP-103A, maple sugar with strychnine; (2) TP-103A, maple sugar with microsized arsenic; (3) TP-146, lanum with strychnine; and (4) TP-146A, lanum with microsized arsenic. In each test 10 hares were liberated in the 4-acre inclosure several days before the experiment started so that they could become established in the new surroundings. The male-female ratio for each test was as follows: (1) 3:7, (2) 5:5, (3) 6:4, (4) 5:5. Each hare was earmarked with both a metal and colored celluloid tag for easy identification. After the animals had become accustomed to the new habitat 10 poisoned aspen boughs treated with one of the above formulas were introduced at various locations in the pen where tracks indicated there was hare activity. Each day for a week thereafter a traverse was made of the area using a 40-foot square grid system as a guide. A daily record was kept of live hares seen, number dead, their location, and the amount of bark eaten at each station. At the end of the week the poison stations were removed and the remaining hares live-trapped from the area and returned to the holding cages for observation. One hare which remained in the pen after the completion of the third test was left as a part of the test 4 population.

The differences shown are not particularly significant because there is speculation as to what happened to the unaccounted-for hares. They may have died from shock disease, exposure, predation, shooting by hunters, or have escaped through breaks in the fence.

The data in Table 22 indicate that the maple sugar-strychnine formula caused a 60 to 80 percent kill; the maple-sugar arsenic formula a 70 to 100 percent kill; the lanum-strychnine 60 to 70 percent kill; and the lanum-arsenic a 50 to 70 percent kill. Table 23 gives the estimate (in square inches) of the amount of bark eaten by the hares at the aspen stations.

The above data seem to isolate thetype of poison as the determining factor in the amount of bark consumed by hares. The evidence indicates that strychnine is less objectionable to hares than arsenic since the acceptance was greater. Arsenic being a slow poison and accumulative may account for the superior results obtained with the arsenic formula. The erratic feeding habits of different hares is also reflected in the table.

Cage Poison Tests

Some of the poison formulas were further tested with hares placed in individual cages made of poultry netting. The dimensions of each were 4' x 3' x 2'. Each cage had the sides covered with burlap for wind protection and seclusion. Each hare was given one aspen bough about 2 feet long and 1/2 inch in diameter, which had been treated with one of the poison formulas. No other food was available to the animals during the test. Table 24 shows the results of these tests.

TABLE 22.--Summary of poison tests under field conditions (4-acre pen). Ten hares were used in each test.

	Number of test			
	Ms-Str*	Ms-Ars*	La-Str*	La-Ars*
Poisoned--				
Found during test	5	5	6	5
Found dead in spring	1	2	0	0
Total	6	7	6	5
Unaccounted for--				
Possibly poisoned	0	2	0	2
Total poisoned (Positively and possibly)	6	9	6	7
Trapped--				
Found dead in trap	0	1	1	0
Died in cages shortly after	2	0	0	0
Total number of hares possibly affected by poison	8	10	7	7
Possible percent of effectiveness	80	100	70	70
Trapped--and alive in cages at the end of study	2	0	2	0
Untrapped--remaining in pen	0	0	1	3
Total number of hares known to be unaffected by the poison	2	0	3	3

* Code: Ms-Str = Maple sugar-strychnine
Ms-Ars = Maple sugar microsized arsenic
La-Str = Lanum-strychnine
La-Ars = Lanum-microsized arsenic

TABLE 23.--Amount of poisoned aspen bark eaten (in square inches) by hares at the various stations and totals consumed for each formula.

Station number	Maple sugar-strychnine	Maple sugar-arsenic	Lanum strychnine	Lanum arsenic
1	8	0	18	5
2	3	9	2	10
3	9	0	8	0
4	31	0	0	4
5	1	0	0	0
6	5	6	8	0
7	12	4	1	5
8	2	7	10	10
9	44	11	3	0
10	1	15	16	0
Totals	116	52	66	34

TABLE 24.--Cage tests with poison aspen sticks

Tag number of test animal	Sex	Poison preparation	Killing time in hours*	Bark eaten in sq. in.	Remarks
229		Ms-strychnine	6	7	
300		"	6	5	Average 6 sq. in.
215		"	18	5	
225		Ms-arsenic	4	5	Considerable diarrhea
212		"	18	3	
216		"	18	2	Average 3 sq. in.
240		"	18	2	
222		"	24	2	
231		"	24	3	
223		La-arsenic	4	6	Average 3 sq. in.
295		"	18	3	
299		"	-	6	Alive after 43 hours. Took clean food readily when offered.

* Killing time indicates number of hours between time of poison placement and when hare was found dead. The time may have been less than indicated but never longer.

The results of these tests are not conclusive for too few animals were available to give reliable results. The greater amount of bark consumed by the animals on the strychnine treated sticks may be due to the presence of tannin which tends to counteract the poisonous effects of strychnine to some extent. Until additional trials can be run to determine the effect of the maple sugar spreader on attracting deer, recommendations for field trials cannot safely be made.

Deterioration Tests

The deterioration tests were not completed due to a lack of hares. The necessary boughs were painted in January and placed in hare-free Pen 4 for exposure to winter climate, but they were later destroyed.

Field Poison Tests

Field tests under regular plantation conditions were planned but due to the lack of final authorization they were not inaugurated.

Suitable areas for these tests were found on the Nicolet National Forest and on state plantations by Mather, Olson and Mackie. Should this study again be undertaken, these areas are here described so that they might be utilized. The National Forest areas were in the S 1/2 of NW 1/4 and the SW 1/4 of the NE 1/4 of Section 17, Township 37 North, Range 15 East. The state areas were in the NE 1/4 of Section 14, Township 35 North, Range 8 East (Lincoln County) and in SE 1/4 of the SE 1/4 of Section 35 North, Range 9 East (Oneida County).

Poison Study Conclusions

1. The preference tests with the three basic formulae -- maple sugar, corn syrup, and lanum -- indicated maple sugar to be the most readily accepted.

2. The effectiveness of the four poison preparations tested was not considered significantly different, although the maple sugar-arsenic formula did produce slightly better results.

3. The slight evidence favoring the use of maple sugar-arsenic paint on aspen boughs may probably be offset by the possible attractiveness of maple sugar to deer and other animals. Beyond this there is also the problem of clearly demonstrating that poison as a method of hare control can be resorted to without endangering beneficial forms of wildlife. From past experience this is most important for until public sentiment toward lethal methods of control is changed, the use of poisons will be definitely limited.

MISCELLANEOUS DATA OBTAINED INCIDENTAL TO THE REGULAR PROGRAM OF WORK

Hare Damage to Natural Vegetation

While the regular examinations for hare damage to planted trees in Pen 2 were being made, observations were recorded on the incidence of feeding on naturally established coniferous trees. Table 25 shows the extent of such feeding.

TABLE 25.--Natural coniferous seedlings in Pen 2 and the percent of hare damage to different species

	Balsam	Black spruce	Hemlock	White pine	Tamarack	Total
Total number of trees recorded	77	9	4	3	3	96
Percent of trees damaged	35	66	100	100	66	44

The degree of nipping varied from the removal of the end of the branches to cutting the tree at the ground level, however, most of this damage was of minor significance and consisted primarily of removing the new growth at the tips of the branches.

A number of hardwood species, including basswood, sugar maple, red maple, yellow birch and aspen and such shrubby growth as hazel, mountain maple, raspberry, blueberry, and leather-wood were cut by the animals. A major portion of the pole-sized aspen and a few of the sugar maple and cherry trees that were felled during the construction of the fences were barked during the winter months. A few standing aspen, 1 to 2 inches in diameter, were girdled a distance of 2 feet above the snow.

The Use of Burrows by Hares

It is generally believed that snowshoe hares do not use burrows. Observations of their use were therefore recorded. One burrow at the base of an old stump was used by hares in several of the successive poison tests. The animals could always be seen near this stump and they always retreated into the hole when approached. Three instances were noted where a form at the beginning of winter gradually developed into a snow tunnel as the winter progressed.

Breeding Data

From the records of young born in the holding cages and dates of observed matings, the gestation period was determined to be between 34 and 36 days. The number of young born in captivity to 9 females was 22 or an average of 2.42 per litter. The earliest litter was born on April 24. The study ended on June 30 so no late season records are available.

Holding Cages

During the course of the study 2 sets of holding pens were constructed. These were built off the ground about 2 feet for sanitary reasons. Each unit was composed of 20 individual pens, 10 on each side of a center aisle. Each cage was $3\frac{1}{2}'$ x $8\frac{1}{2}'$ x $5\frac{1}{2}'$ in size and opened into the center aisle by a door which swung outward. Doors on opposite sides of the aisle when opened touched, forming a blockade, which made the task of driving hares from one pen to another quite easy and did not excite them. The sides and top of the cages were covered with 1 inch poultry wire to prevent escapes and to exclude predators. A two-foot band of burlap was tacked around the outside of the whole battery of cages to give wind protection and seclusion from nearby activities. Photograph D (Plate 2) shows the two sets of cages and photographs E and F show the interior construction of several of them.

PHOTOGRAPHIC SECTION

A number of pictures of this hare study were made and are added to this report for the purpose of clarifying some of the descriptions of equipment and habitats. Each picture is accompanied by a complete description so no further discussion in the body of the report is necessary.

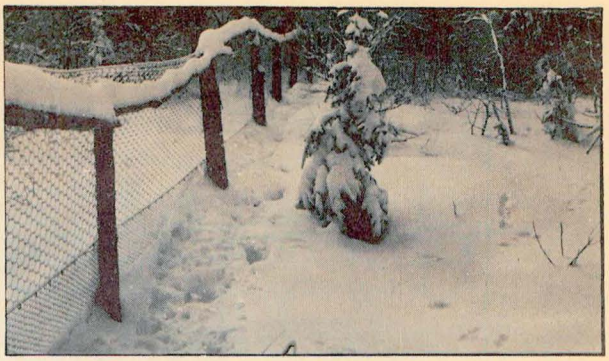
RECOMMENDATIONS FOR FUTURE STUDIES

Repellents

The above studies have shown that repellents such as T. P. 109 do protect young transplants from snowshoe hare attack as long as it covers the edible portion, but when new growth appears, they apparently receive no protection from the old spray. Follow-up spraying in the field seems to be the only way of continuing this protection but until this can be tested as to effectiveness and cost no recommendations for this procedure can be made.

A

B



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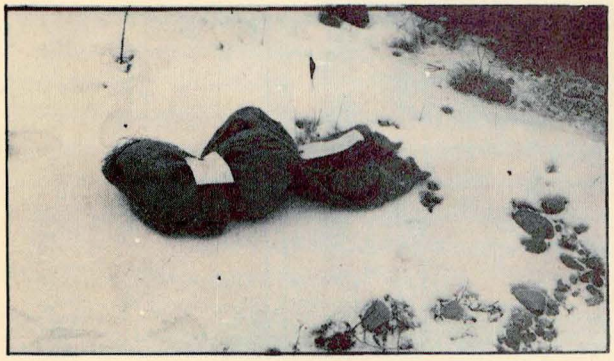

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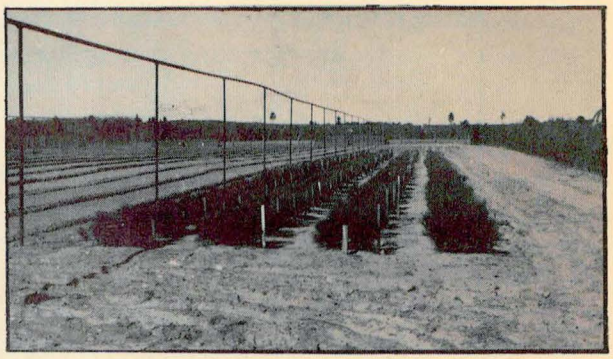

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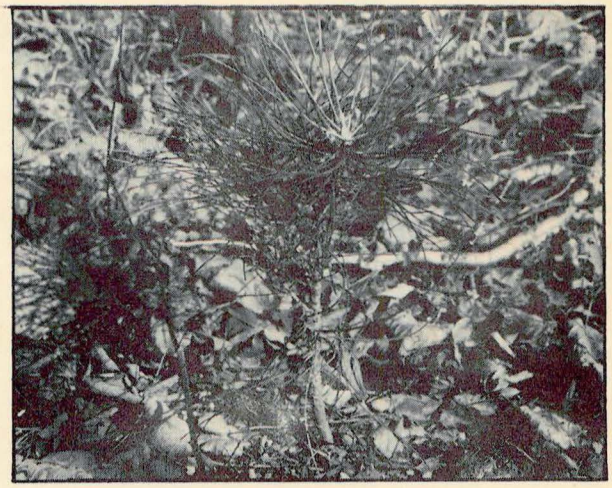
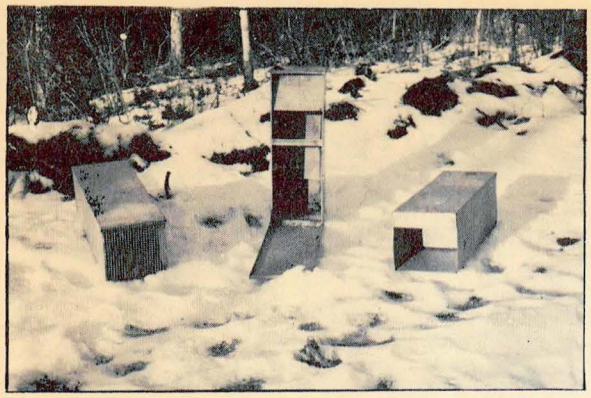


PLATE 1.-- A - Service road into snowshoe hare, showing type of stile used and general habitat of the area. B - One of the pen fences and a hare trail along it. C - A section in Pen 1 showing placements of lath markers. D - Released snowshoe hare in its form. E - Carrying sack for transporting live hares. F - Repellent study at the Hugo Sauer Nursery. G - Treated red pine which has had almost all of new growth removed by hares.

A



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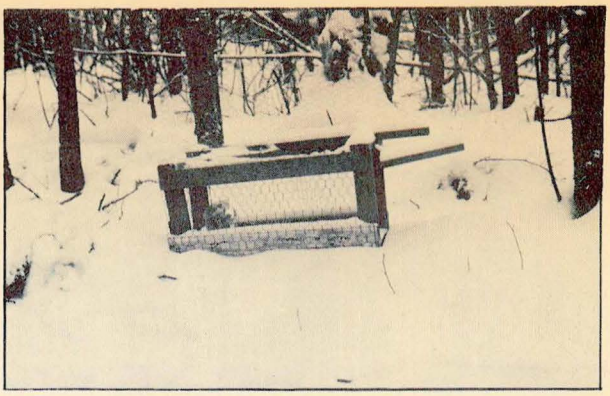

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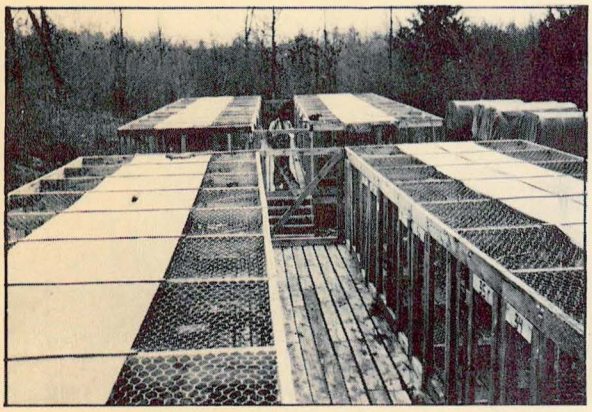

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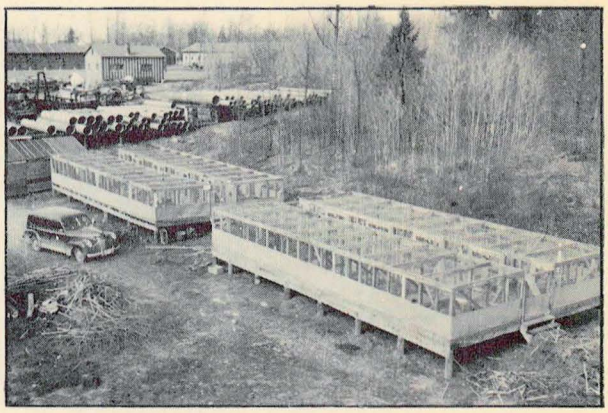

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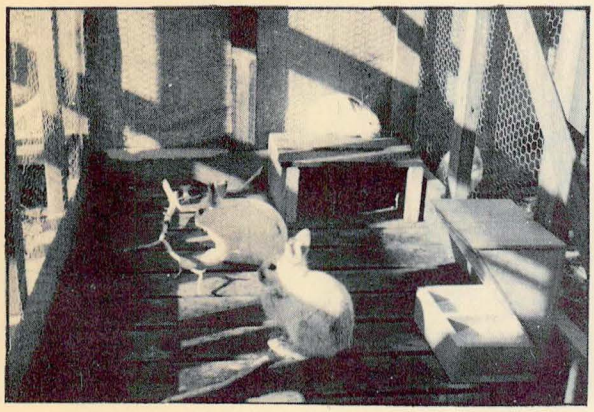

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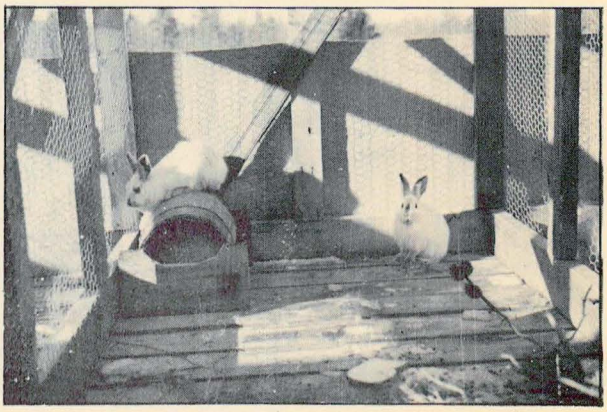

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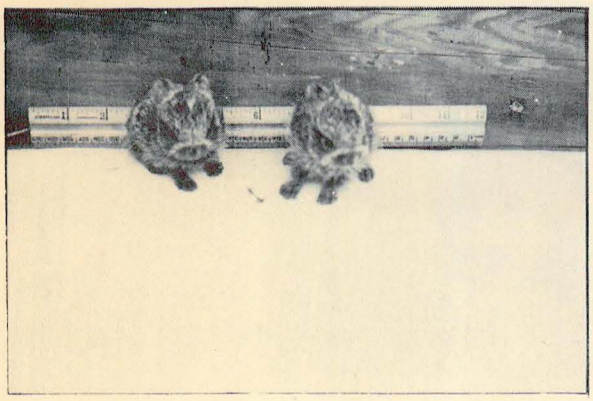
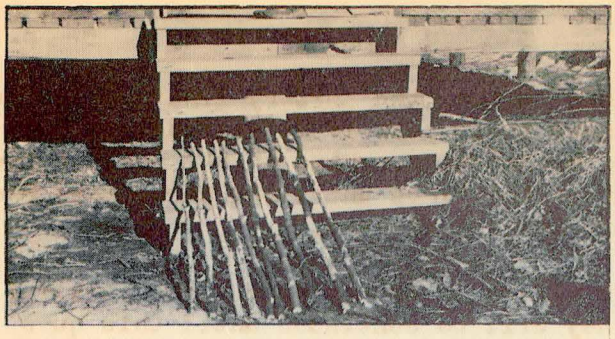


H

PLATE 2.-- A and B - Live traps used for catching snowshoe hares. C and D - Holding pens at Blackwell CCC Camp. E and F - Interior of individual cages showing construction, self feeder for grain and nest boxes. G - Day old snowshoe hares. H - Mother with two young raised in holding cage.



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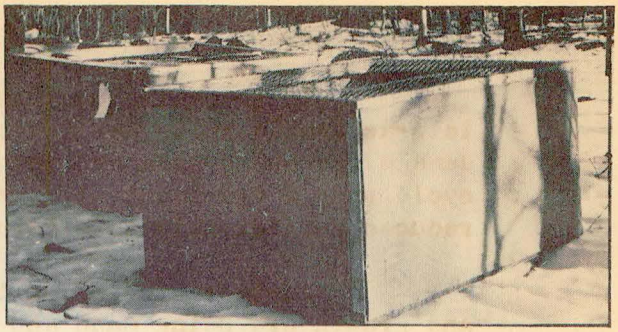

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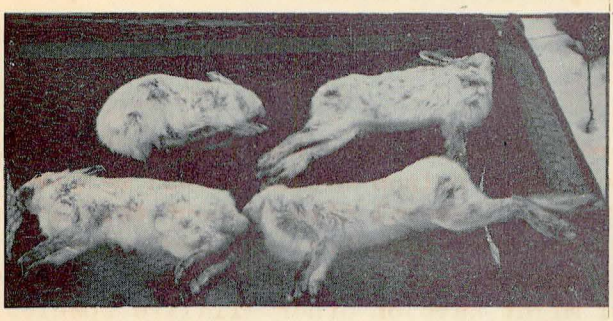

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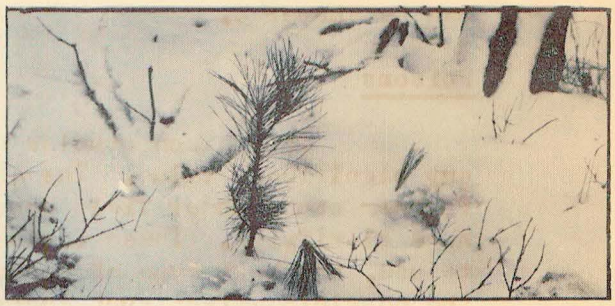

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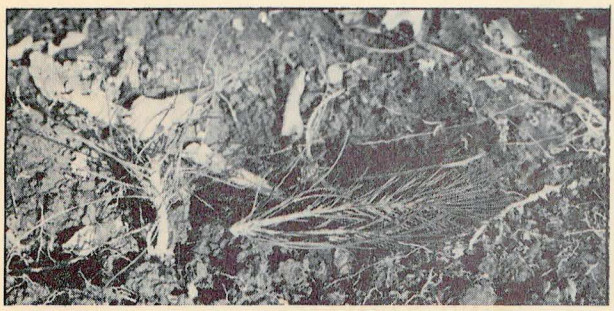

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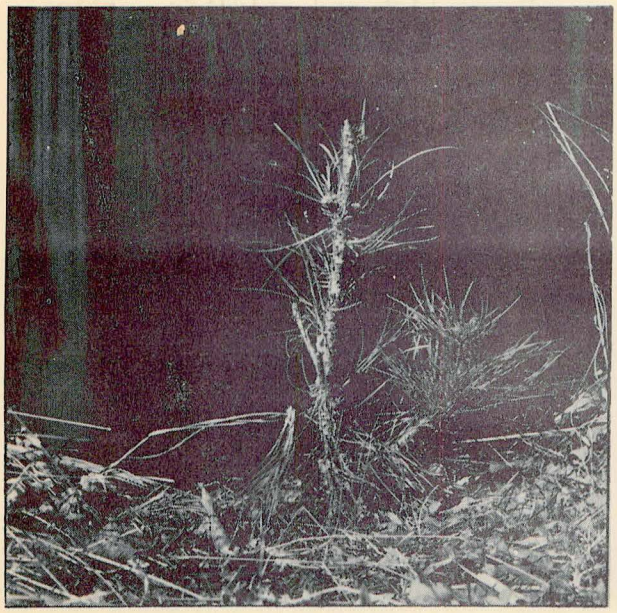

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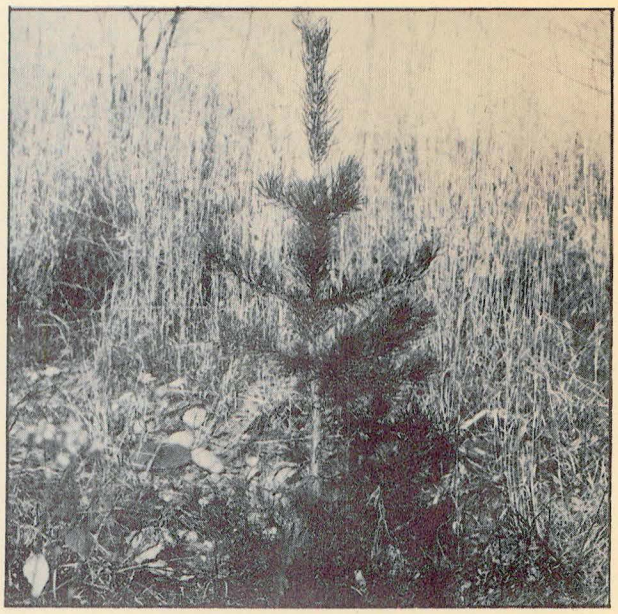

H

PLATE 3.-- A - Sticks used in basic formula tests. B - Cages used for poison. C - Death attitudes. At left arsenic and at right strychnine. D, E, and F - Young red pines damaged by snowshoe hares within pens at Blackwell. G - Jack pine, 5 years old, repeatedly damaged by hares in field plantation. H - Jack pine in same plantation as G but uninjured.

It is still questionable whether the nursery treatment of trees is practicable while hares are near their peak if it only delays the damage for one season or part of a season. Perhaps at the peak of the cycle such a treatment will protect the trees until the hares have been reduced sufficiently to eliminate their influence.

Further studies on the effect of the spray on tree survival and growth are being made and they will be continued until this question can be answered.

Poisons

The poison studies herein reported were too limited to be of any significant value. The aspen bough poison method should be given further study under field conditions. Several things about this method need clarifying. These include: the most effective and economical poison to use, the best type of aspen boughs to use and their distribution, and the possible effect such control might have on other wildlife species.

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